

# U.S. GEOLOGICAL SURVEY NATIONAL COMPUTER TECHNOLOGY MEETING: PROGRAM AND ABSTRACTS, MAY 7-11, 1990

Compiled by Barbara H. Balthrop and Eva G. Baker

U.S. GEOLOGICAL SURVEY

Open-File Report 90-161



Nashville, Tennessee  
1990

PRELIMINARY COMPARISON OF GROUND-WATER SITE INVENTORY INFORMATION IN  
THE U.S. GEOLOGICAL SURVEY'S NATIONAL AND DISTRIBUTED DATA BASES  
LIEBERMANN, Timothy D., USGS, WRD, 2301 Bradley Avenue, Louisville,  
KY, 40217

As part of an evaluation of the U.S. Geological Survey's ground-water site inventory information data base, procedures were developed to compare the National Water Storage and Retrieval data base with the distributed National Water Information System data bases. Comparison of the two systems is not straightforward because their retrieved outputs differ in organization, format, sorting order, and component numbering. To solve the problem, a set of programs were written using Prime's Command Programming Language and Fortran. The programs are easy to use and give the user flexibility regarding sites retrieved and comparison criteria.

The procedure consists of two major steps, each controlled by a single Command Programming Language program. The first program assembles job decks and retrieves ground-water site inventory data from the National Water Storage and Retrieval data base and the National Water Information System into separate data files. Because of limitations on size, several retrievals per state are usually necessary. A second Command Programming Language program controls the remaining procedures. The data files are converted to a standard, compact format, then joined and sorted. The National Water Storage and Retrieval data base and the National Water Information System data are handled separately. The two data sets are then compared using a stepwise method, based on successive matches between site identifier, component group, sequence number, and component value. The component values can only be compared if agreement occurs at each preceding step. A summary of comparisons for each component is produced, along with a detailed list of discrepancies, which can be used as a basis for error corrections. Individual summaries of the two data bases are also produced.

Initial comparisons for five states indicate that the two data bases differ greatly in the number of sites and components they contain, but that differences in compared data values are relatively minor. Inconsistencies often seem to reflect systematic differences in structure, error checking, or data transfer between the two data bases.

A METHOD FOR DESCRIBING STREAM-DRAINAGE-SYSTEM TOPOLOGY IN A GEOGRAPHIC INFORMATION SYSTEM

LORENZ, David L., USGS, WRD, 702 P.O. Bldg, St. Paul, MN 55101

Describing stream-drainage systems in a geographic information system presents special problems and opportunities. Locations on a stream are commonly referenced by distance upstream or downstream from a given point. Although geographic information system software can easily manipulate map data, it stores locations in a Cartesian coordinate system rather than as distances along a path. The concept of dendrite topology was developed as a link between existing methods and the extraction of information about a stream system and its related basin characteristics.

The term dendritic describes the structure of a tree and its branches; dendritic structure can resemble the drainage pattern of a stream and its tributaries. Dendrite topology contains lines and points. The line component consists of a collection of arcs that describe a stream trace--the path that an average particle of water travels from the drainage divide to the mouth or specified end point. The trace is continuous and passes through marshes, lakes, and the midline of wide rivers and braided streams. Each stream trace has a unique identifier. The point component is a single label that identifies the endpoint of a stream trace, normally at its mouth where it joins another stream trace.

Dendrite topology was defined and used to calculate the length and slope of streams in the Redwood River basin in southwestern Minnesota. Known elevation points on the river system were obtained from U.S. Geological Survey 1:24,000-scale topographic maps. These points were identified by the stream identifier and downstream distance. The outlet locations of subbasins within the river system were identified by stream identifier and basin identifier. A computer program was written to calculate the length of the main channel from the headwaters divide to the mouth and to locate points 10 and 85 percent of the distance from the mouth to the headwaters divide. The main channel slope was determined using interpolated elevation data at the 10- and 85-percent-point locations and the previously determined channel length between those points.

**HYPertext DOCUMENTATION OF A GEOGRAPHIC INFORMATION SYSTEM**  
**MAJURE, JAMES J., USGS, WRD, Room 269, Federal Building, 400 South**  
**Clinton Street, Iowa City, IA 52244-1230**

A hypertext tool was used to document a geographic information system. Hypertext allows non-sequential access to text in a document. Text, such as a word or paragraph, can be connected to text elsewhere within the same or other documents. The use of a mouse to click on the text immediately changes the location of the cursor within a document to that of the connected text. The data sets in the geographic information system being documented contain data that represent relevant geographic features such as wells. These data sets are divided into classifications, such as surface water and ground water. The classifications are listed and briefly described, and hypertext is used to connect the name of each classification to a list of data sets within the classification. Likewise, the name of each data set is connected to a data dictionary for the data set. If a data set is logically included in more than one classification, the hypertext document can reflect this by including the name of the data set in each appropriate classification and connecting each name to a single data dictionary. This allows data sets to be documented in a way that minimizes redundancy of both documentation and data, and, at the same time, provides a flexible method to search for data sets in the database. A hypertext index that lists the name of each classification, subclassification, and data set is also provided. Each name is directly connected to the appropriate page in the document. This allows users who are familiar with the database to directly access data set documentation without searching through each classification and subclassification.

## TRANSFERRING COMPUTER PROGRAMS BETWEEN DIFFERENT COMPUTERS

MCFARLANE, Scott I., USGS, WRD, Room W-2518, 2800 Cottage Way, Sacramento, CA 95825

After the award of the Distributed Information System-II (DIS-II) contract, current Formula Translation (Fortran) programs may need to be revised to be compatible with the new Distributed Information System-II computers and compilers. This paper identifies some of the problems, solutions, and steps to minimize problems when a computer program is transferred to another computer.

One problem occurs when the original programmer assumes that the compiler is going to implement Fortran statement(s) in a particular way. An example is expecting variables local to a subroutine to retain the last value assigned when reentering the subroutine. Assumptions such as this may not be valid for all Fortran compilers. To fix this type of problem, the programmer needs to search for places in the program where the problem is likely to occur, and modify the program to assume only implementation details specified in the Fortran standard.

The easiest type of problem to locate in a program probably is syntax that does not conform to the American National Standards Institute (ANSI) Fortran standard. Language extensions commonly cause syntax errors when compiling with different compilers. To fix these problems, the programmer needs to rewrite these constructs using only statements that conform to the ANSI Fortran standard. Many of these problems may be detected and fixed by using the ANSI switches, such as Prime's -STANDARD switch. These switches instruct the compiler to print messages when it detects statements that do not conform to the ANSI standard.

Differing word size and number representations for computers and compilers may cause transferred programs to produce incorrect results. A computer might not be capable of representing a number that is calculated or the differing accuracy of number representation can cause high truncation error. The program might run successfully, but produce different or incorrect results. A solution could be to increase the precision of some of the variables.

Whether a new Distributed Information System-II workstation is available or not, the conversion effort can be started immediately by ensuring that Fortran programs conform to the ANSI standard.

SOFTWARE QUALITY ASSURANCE IN THE NATIONAL WATER INFORMATION SYSTEM  
PROGRAM OF THE U.S. GEOLOGICAL SURVEY

MERK, Charles F., USGS, WRD, MS 437 National Center, Reston, VA  
22092; DEMPSTER, George R., Jr., USGS, WRD, MS 437 National Center,  
Reston, VA 22092

The U.S. Geological Survey's water data-processing computer software systems are developed and maintained by the National Water Information System (NWIS) Program of the Water Resources Division (WRD). The system is currently being redesigned for use on 32-bit microprocessors (workstations) and file servers to be located in WRD offices across the Nation. A software life cycle provides the framework for guiding and accomplishing the development.

Software quality assurance is a planned and systematic pattern of all actions necessary to provide confidence that the software conforms to established technical requirements. The software quality assurance program focuses on the establishment of standards, reviews, testing, and software configuration management procedures throughout the software development life cycle. Software quality assurance depends on uniform terminology and communication among users, developers, and managers. This paper explains the implementation of software quality assurance and quality control in the NWIS.

USE OF A GEOGRAPHICAL INFORMATION SYSTEM TO INTEGRATE AND ANALYZE  
MULTIPLE GROUND-WATER DATA BASES

ORONA, M.A., USGS, WRD, 227 N. Bronough St., Suite 3015,  
Tallahassee, FL 32301; CHOQUETTE, A.F., USGS, WRD,  
227 N. Bronough St., Suite 3015, Tallahassee, FL 32301;  
KATZ, B.G., USGS, WRD, 227 N. Bronough St., Suite 3015,  
Tallahassee, FL 32301; and PENDEXTER, W.S.; USGS, WRD,  
227 N. Bronough St., Suite 3015, Tallahassee, FL 32301

A large ground-water quality data base for the nematocide 1,2-dibromoethane (EDB) was used to evaluate methods for regional water-quality assessment as part of the U.S. Geological Survey pilot National Water-Quality Assessment Program. Two methods of study were used in an effort to understand the factors affecting the EDB contamination of ground water. In four regional-scale study areas of 50 to 200 square kilometers, the occurrence of EDB in ground water was statistically related to potential controlling factors. Concurrently, a mass-balance modeling approach was used to study the transport and fate of EDB in the subsurface at a local scale of less than 2 square kilometers.

A Geographical Information System (GIS) was used to integrate the EDB data base containing information from a ground-water sampling network of more than 5,000 wells with other spatial data bases within the study areas. The integrated data base has more than 80 descriptive items. The GIS (ARC/INFO) was used to quantify potential factors affecting ground-water quality. For example, digital data were used to determine depth to the water table and distance from EDB application sites to wells. Physical and chemical properties of soils underlying application sites were determined by using digital soil data. The depth of specific soil horizons and the areal extent of soil units within EDB application sites were used to calculate weighted mean soil characteristics. GIS routines were used to determine the aquifer sampled by individual wells and to obtain subsamples of wells that are not correlated. Base maps, figures, and slides for technical papers and presentations were also made with the assistance of GIS.

**WATER-BUDGET AND REMOTE-SENSING TECHNOLOGIES COMBINE TO ACCOUNT FOR WATER USE ALONG THE LOWER COLORADO RIVER**

OWEN-JOYCE, Sandra J., USGS, WRD, 300 W. Congress St., Federal Bldg., FB-44, Tucson, AZ 85701; VON ALLWORDEN, B. K., USGS, WRD, 3738 North 16th St., Suite E, Phoenix, AZ 85016

The Lower Colorado River Accounting System (LCRAS) combines hydrologic water budgets, digital-image analysis of satellite data, and geographic information system technologies to quantify consumptive use of water from the lower Colorado River. A regional water-budget approach is the basis for a system by which annual consumptive use of river water can be estimated within the 12,500-square-mile study area. Analysis of satellite data provides vegetation types and associated acreages. The acreages multiplied by water-use rates give estimates of evapotranspiration. The boundaries of each user's area are delineated, digitized, and entered in a data base by using geographic information system software to obtain the spatial distribution of consumptive use.

LCRAS is a modular computer program designed to process the large quantities of data and to combine the output from water budgets with the output from digital-image analysis. LCRAS was designed for (1) annual accounting but can also be operated as a planning tool, and (2) easy modification as new data, software, and improved techniques become available. Within LCRAS, annual consumptive use of lower Colorado River water by vegetation is estimated with water budgets and distributed areally by using estimates of evapotranspiration calculated for each diverter from image analysis and digitized boundaries. LCRAS also accounts for evaporation from open-water areas and for domestic, municipal, and industrial consumptive use. LCRAS contains a single-reach option and a four-reach option that are used to estimate and distribute consumptive use to water users in the 320-mile reach between Hoover Dam and Morelos Dam. The single-reach option provides data for the entire flood-plain area, and the four-reach option provides data for the four subreaches. Water-data inputs to the program are selected to reflect the different hydrologic conditions in each individual subreach of the lower Colorado River.

INTEGRATING THE FEDERAL WATER DATA COORDINATION PROGRAM WITH THE NEW  
NATIONAL WATER INFORMATION SYSTEM PROGRAM

Parks, Bruce, USGS, WRD, 417 National Center, Reston, VA 22092

Recent legislation and changing priorities in such environmental activities as waste disposal and clean-water production have created a need for additional water-resources information. New technology is improving the ability to collect, process, archive, and disseminate water-resources information. The U.S. Geological Survey (USGS), through the National Water Data Exchange and the Water Resources Scientific Information Center, provides users outside the USGS with water-resources information from the Water Data Storage and Retrieval System, the Master Water Data Index, the Water Data Sources Directory, and the Environmental Protection Agency's STORET system. With the establishment of a national water information clearinghouse within USGS, the USGS is expected to have an expanded role not only in collecting, archiving, and disseminating its own data, but also in providing information about data collected by other Federal and non-Federal organizations.

In 1964, the Office of Management and Budget assigned to the Department of the Interior the lead responsibility for coordinating Federal activities in the acquisition and sharing of water-resources information. This includes, among other responsibilities, acquiring, indexing, and disseminating information on the water-resources data and activities of all Federal and non-Federal organizations. The Department delegated its leadership role to the USGS. Within the USGS, this delegation was extended to District and Regional offices of the Water Resources Division for leadership and coordination within their geographic areas of responsibilities. The USGS is not the repository for data collected by other agencies, but does have a responsibility for maintaining and disseminating information about other groups' data.

The new National Water Information System being developed by the USGS will integrate the existing centralized data system of the Water Data Storage and Retrieval System, the National Water Data Exchange, and the National Water-Use Information Program. In implementing the new system, the USGS needs to ensure that it addresses two objectives: 1) it needs to be able to compile, process, archive, and disseminate data collected through USGS programs; and 2) it needs to provide access to those data, as well as to information about water-resources data collected by other Federal and non-Federal agencies.

DISTRIBUTED INFORMATION SYSTEM-II TRAINING FOR THE U.S. GEOLOGICAL SURVEY

PORTER, J.L., USGS, WRD, 12201 Sunrise Valley Drive,  
Reston, VA

The U.S. Geological Survey's Distributed Information System Program Office will be responsible for coordinating training activities for the hardware and software that will be used in DIS-II, the second generation of the System. Courses will include System Administration, Programming, Data Base Management, Spreadsheet, Graphics, Windowing Tools, Illustration Software, Electronic Report Processing, Computer Security, and others. A Training Plan will explain how instructors will be selected and how the classes will be announced. A Training Course Schedule will contain course descriptions and schedules, training locations, and registration procedures. Training services will include video-based and (or) computer-based training, a reference library, and training administration.

## ARCHIVING ON-LINE DATA TO OPTICAL DISK

PORTER, J.L., USGS, WRD, 12201 Sunrise Valley Drive,  
Reston, VA 22092; KIESLER, J.L., USGS, WRD, 4710 Eisenhower  
Boulevard, Tampa, FL 33634; STEDFAST, D.A., USGS, WRD, 102  
East Main Street, Urbana, IL 61801

The U.S. Geological Survey has stored instantaneous values of hydrologic data (unit values) on minicomputers since 1985. A substantial amount of disk storage is required for the on-line storage of these data. Traditionally, these data have been archived on magnetic tape to make disk storage space available for additional data. However, magnetic tapes have a limited shelf life, and retrieval of data for a specific site is cumbersome. As the volume of unit-value data to be archived has expanded, the need for a more efficient method for data storage and retrieval has increased.

The Geological Survey's Distributed Information System Program Office is currently (1990) assessing optical disk storage as an alternative means of archiving unit-value data. Optical disks have a longer shelf life than magnetic tapes, and retrieval of archived data is substantially easier. The cost for data storage on write-once/read-many optical disks is comparable to that of magnetic tape and only a fraction of the cost for magnetic disk data storage.

In a test study, unit-value data will be archived using one optical disk drive connected to a microcomputer and a second drive connected to a minicomputer. The cost of data storage, alternative forms of data storage, and specifications for data retrieval will be described.

USE OF A GEOGRAPHIC INFORMATION SYSTEM TO IMPROVE LOCATION  
DATA IN A NATIONAL POLLUTANT DISCHARGE DATA BASE

PRICE, Curtis V.; ROBINSON, Keith W., USGS, WRD, 810 Bear Tavern  
Road, West Trenton, NJ 08628

The U.S. Environmental Protection Agency's national data base for permitted wastewater discharges, known as the Permit Compliance System (PCS), is being used in a water-quality-modeling study in New Jersey. The PCS contains information on each permitted discharge, such as permit number, name, location (geographic coordinates), and discharge quantity and quality. The modeling effort requires accurate location data for all wastewater discharges, but preliminary analysis indicated that the data base contains locations for only 983 of the approximately 1,200 discharges permitted in the State. Additional spot checks revealed that some of these locations were inaccurate.

In order to evaluate the quality of the location data, community names recorded in the PCS were matched with entries in the U.S. Geological Survey's Geographic Names data base--a tabular data file of names of cultural and natural geographic features--by using relational data-base techniques and manual comparison of files. A geographic information system (GIS) was used to overlay the locations derived from both data bases with municipal boundary polygon data. For both sets of locations, this overlay operation resulted in the assignment of the municipal code of an overlying polygon to each discharge. Subsequent comparison of the two municipal codes associated with each discharge showed that municipal codes matched for 647 of the 983 discharges. If the municipal codes did not match, location information was obtained from other sources.

The results of the study indicate that (1) regional water-quality studies require more accurate location information for sources of contamination than commonly is available in national data bases, such as the PCS; and (2) a GIS can be used effectively both to evaluate the overall accuracy of a spatial data set and to identify individual records with poor spatial accuracy.

USE OF REMOTE-SENSING DATA TO MAP IRRIGATED CROPS IN SOUTH-CENTRAL TEXAS  
RAYMOND, Lee H., USGS, WRD, 8011 Cameron Road, Austin, TX 78753

The U.S. Geological Survey, in cooperation with the Edwards Underground Water District, is adapting a classification technique that uses remote-sensing data to map and calculate the areas of irrigated crops by county in south-central Texas. The time and cost of obtaining this information by field reconnaissance is prohibitive; sources from which the information was obtained in the past are no longer available.

Landsat digital satellite images for March and July 1989 were combined and classified to identify the areas of irrigated crops. Normalized difference was used to discriminate vegetation from nonvegetative ground cover because it is more sensitive to the sparse vegetation cover in March than are band ratios, which have been used in previous applications of this technique. Maximum likelihood was the unsupervised classifier. The digital-image classification was calibrated by crop distribution data collected during field reconnaissance in part of the irrigated area in July 1989. Boundaries of the areas irrigated with water from the Edwards aquifer were drafted onto maps, digitized, and registered to the classified image to separate the irrigated areas from the rest of the image and to calculate the number of acres of each crop in each area.

The principal crops classified for 1989 were corn (33 percent of the total irrigated area), cotton (21 percent), and alfalfa grown for hay (6 percent). The rest of the total irrigated area, to which water was not applied in 1989, consisted of fallow and idle fields (29 percent), mixed-grass pasture (9 percent), and unidentified vegetation (2 percent). Uvalde County had the largest total area irrigated with water from the Edwards aquifer (93,000 acres) and Bexar County had the smallest area (2,800 acres).

## A COMPUTER PROGRAM TO DETERMINE MAP COORDINATES FROM PUBLIC LAND-SURVEY COORDINATES

REA, Alan H.; SCOTT, Jonathon C., USGS, WRD, 215 Dean A. McGee Ave., Room 621, Oklahoma City, OK 73102

Site locations in many states may be described using "local numbers" derived from the township, range, and section designations of the U.S. Public Land-Survey System. Where Public Land-Survey boundaries are available on topographic maps, local numbers generally are easier to determine than latitude and longitude. Many data bases maintained by federal and other agencies report location only by local numbers. Because the Public Land-Survey System is based on an irregular gridding system it can be difficult to translate local numbers directly into geographic coordinates for mapping and analysis.

A Fortran program was written to transform local numbers into a specified map coordinate system. The program uses proprietary ARC/INFO Geographic Information System subroutine calls and extracts map coordinates for the corners of the section of interest from computerized map data. The section is subdivided into quarter-sections, then each quarter-section is subdivided into quarters -- to a maximum of four levels of subdivision. Then, the map coordinates at the center of the subsection are computed by interpolation. Optionally, a file containing a set of alternate coordinates such as latitude and longitude can be read. The program can calculate the distance between the computed coordinates and alternate coordinates and determine if the distance is greater than acceptable limits.

The program can be used to check for errors in the locations of sites stored in the Geological Survey's data bases. Latitude-longitudes have been compared with local numbers for over 1,000 sites in Oklahoma, revealing a number of errors or inconsistencies in coordinate data that had been hand-checked several times. The program has also been used to identify irregularly-shaped sections in computerized maps.

AN INTERACTIVE COMPUTER PROGRAM, GWARC, TO CREATE A GEOGRAPHIC  
INFORMATION SYSTEM DATA SET FROM GROUND-WATER SITE INVENTORY DATA  
ROLON-COLLAZO, Lourdes I., and GONZALEZ, Philip, USGS, WRD,  
GPO Box 4424, San Juan, PR 00936

A computer program, GWARC, was developed to interface data from the Ground-Water Site Inventory subsystem of the U.S. Geological Survey's National Water Information System with the geographic information system, ARC/INFO. The program, GWARC, was designed to graphically display the information retrieved from the Ground-Water Site Inventory data base. The program is menu-driven and designed for users with limited background on use of geographic information systems. The program has the capabilities to retrieve Ground-Water Site Inventory data, read the output files, and manipulate the information to produce an ARC/INFO point-coverage file of spatially distributed data points. The program then merges the point-coverage file with an existing digital map-coverage file and produces a plot file that can be input to a variety of graphical devices. The program was written for the Prime Series 50 minicomputers and combines Fortran 77, Prime's Command Procedure Language, and ARC Macro Language subroutines. With minor modifications, GWARC can be implemented in other computer systems.

**NATIONAL WATER CONDITIONS, A PERIODICAL PUBLISHED BY THE U.S.  
GEOLOGICAL SURVEY**

**ROSS, Thomas G., USGS, WRD, 419 National Center, Reston, VA 22092**

The National Water Conditions (NWC) is a monthly periodical published by the U.S. Geological Survey, in cooperation with Canada's Department of the Environment, Water Resources Branch, since October 1944. The switch from a Multics computer data base to a Prime minicomputer data base was begun in summer 1985. Since then, the NWC and its reporting system have undergone many changes, including the transition from a cut-and-paste document to a desk-top electronic-report document. The transition has been difficult at times but rewarding because of the current ability to process and present hydrologic data in tables, maps, and graphics for use by the NWC staff in preparing the NWC, in the NWC itself, and also for use in briefings, both within and outside the U.S. Geological Survey. NWC products range from the hard copy of the NWC itself to video presentations and computer presentations in both Microsoft disk-operating system and Apple formats. The future can only bring more change in the process as used to prepare the periodical and the periodical itself.

THE SPATIAL DATA TRANSFER STANDARD  
ROSSMEISSEL, Hedy J., USGS, NMD, 510 National Center, Reston,  
Virginia 22092

The success of any standard depends on acceptance by the community of potential users. Accordingly, the process coordinated by the U.S. Geological Survey to develop a spatial data transfer standard for use by Federal agencies and the earth science professions was tailored to involve all segments of the profession, including Federal agencies involved in mapping, private industry, and the academic community. This development effort has been difficult and time consuming; however, with a broad base of involvement by a wide range of organizations, a final standard has been produced that will be a significant benefit to users of spatial data.

The development of the standard has been under the direction of a Spatial Data Transfer Standard Technical Review Board. This board was given the responsibility to complete the Spatial Data Transfer Standard for promotion to the National Institute of Standards and Technology as a Federal Information Processing Standard. The board has done a successful job in finalizing the standard by putting together a document that meets the needs of the community and yet is not too complex.

In support of the Spatial Data Transfer Standard, the U.S. Geological Survey will coordinate the development of a suite of software tools to assist users in interfacing with the standard. The availability of user-friendly software support tools is considered to be a critical element that will enhance the promotion of the standard and secure its acceptance throughout the community.

**USING MICROCOMPUTER GRAPHICS TECHNOLOGY AS AN AID IN THE PRESENTATION OF GEOGRAPHIC INFORMATION SYSTEMS PROJECTS**

**SCHACHTE, Brian R., USGS, ISD, 804 National Center, Reston VA 22092 .**

Geographic Information Systems (GIS) project presentations away from the office have been difficult in the past because of specific hardware, software, and communications requirements. However, by using the combination of microcomputer graphic arts software and a variety of output devices, it is possible to manipulate and enhance images of spatial data sets. This provides various types of transportable presentation media.

Postscript printers will provide gray-scale publication-quality illustrations. High-resolution color-image copiers can be used to produce high-quality paper and transparency hard copies. Transparencies can be used further to create color separates of an image that when combined with photographic processes, produce color posters. Other photographic techniques include the use of film recorders that can produce 35-millimeter slides, 4- by 5-inch or 8- by 10-inch negatives. A series of images can be output to video recording devices to provide the user with a video taped presentation, making it possible to demonstrate GIS projects using only a television and video cassette recorder.

ANALYSIS AND PRESENTATION OF GEOPHYSICAL DATA USING A COMPUTER PROGRAM  
SCHAEFER, Donald H., USGS, WRD, 705 N. Plaza St., Room 227,  
Carson City, NV 89701

A commercially available computer program known as Surface III generates surfaces from irregularly spaced X-Y-Z data and allows easy manipulation, spatial analysis, and display of those surfaces. One principal use of the program is to display and manipulate geo-physical data, such as aeromagnetic and gravity fields. The program is especially useful for large regional studies such as the recently completed studies of carbonate-rock aquifers in southern Nevada and Carson Basin National Water-Quality Assessment Program. Plotting of color-shaded contour maps allows an effective method of data presentation as simple contours are often hard to interpret easily.

This computer program is also capable of manipulating large data sets to facilitate data analysis. It reads free-format or user-selected format data files. Various statistical routines are available within the program to detect possible incorrect data values such as a value that differs markedly from the norm. A histogram can be specified for the data set to allow the user to determine quickly the distribution of data and, therefore, the appropriate contour intervals or color bands.

Contour maps can be prepared quickly by using default options that are useful for cursory inspection of the data before a more complex map is constructed. The program draws isometric or perspective and stereo views of the data. This is also a useful technique for viewing the data, especially if the data contain a high-frequency noise component. Highs and lows are readily apparent in relation to the rest of the data set.

The graphics routines of the program are linked to two separate plotting libraries that allow maps and plots to be displayed on virtually any plotting device. Sending the plot to a device-independent plot file allows it to be stored for display at a later time, at different scales, or on any supported device without the computer overhead of re-running the program. With simple command structure, many carefully selected default values, and flexibility in producing visually effective maps, the computer program has proven useful for geophysical data interpretation and display.

AUTOMATION OF CAMERA-READY TABLES OF GROUND-WATER SITE INVENTORY  
WELLS AND SPRINGS

SHANK, Gregory L., USGS, WRD, 228 Walnut St., Rm 450 Federal Bldg.,  
Harrisburg, PA 17108

The current (1990) Ground-Water Site Inventory tabling program of the U.S. Geological Survey's National Water Information System does not produce camera-ready tables suitable for publication. In general, about 40 hours is required for a typist to prepare a table containing well or spring information for publication. A computer program was developed to automate all of the necessary editing and formatting for creation of data tables.

The program is written in Fortran and exists external to the Ground-Water Site Inventory system; it addresses (1) the format and layout of column headings; (2) the components that should appear in every table; (3) the organization and format (number of significant digits) of the data; and (4) the value to retrieve for a component with multiple values. Program output conforms to the style, format, and publication standards of the U.S. Geological Survey and the Pennsylvania District with regard to well and spring tables; the program can be modified for preparing data tables in any format.

The program uses the Ground-Water Site Inventory tabling program's output to produce an American Standard Code for Information Interchange file in publication format. U.S. Geological Survey's publication guidelines require the table to fit on two 8 1/2- by 11-inch facing pages with approximately 1-inch margins. Therefore, special consideration needs to be given to font selection for the printer when camera-ready copy is prepared.

IMAGE-PROCESSING CAPABILITIES RELATED TO  
WATER-RESOURCES INVESTIGATIONS

SMITH, J. LaRue, USGS, WRD, 705 N. Plaza St., Room 227,  
Carson City, NV 89701

Historically, image processing of satellite data for water-resources investigations has been used by the U.S. Geological Survey (USGS) primarily for land-cover classification. The actual processing of data was frequently performed by another agency with the necessary expertise and equipment. A few USGS District offices purchased software and hardware to perform image processing; however, most Districts lacked the necessary expertise in image processing and generally could not afford the expense of the software and hardware. Recently, interest has been renewed in image-processing and analysis because of the expanding use of geographic information systems, reduced cost of software and hardware, development of a user-friendly software interface, and increased knowledge of image-processing techniques and capabilities by scientists.

Computer software and hardware systems and other resources are now available within the USGS for scientists to perform image processing, integrate image-processing capabilities with geographic information system and other software used by the Survey, and generate a variety of output products. Satellite data (before 1984) can be acquired through the Federally Owned Landsat Data Program. The Science and Technology Laboratory Applications Software (ELAS), maintained and distributed by the Stennis Space Center, is designed to analyze and process digital imagery and non-image data. The software was installed on USGS Distributed Information System I computers and has been used by a number of scientists. A major revision of the software includes an online help system, the capability to create user-defined menus, and the development of a UNIX version of the software which would facilitate the use of the software with Distributed Information System II. Interactive display of image data can be accomplished with dedicated display devices or other standard graphic interfaces, but a microcomputer display system is an inexpensive option for viewing data. Laboratories in the USGS provide plot services that create scaled photographic and paper products of enhanced imagery.

**PRESENTATION COMPUTER GRAPHIC SLIDE SERVICE**  
**SOLOMON, Joyce A., USGS, WRD, 445 National Center,**  
**12201 Sunrise Valley Drive, Reston, VA 22092**

The U.S. Geological Survey, Water Resources Division (WRD), Distributed Information System Program (DIS) office in Reston, Va., provides a computer graphic slide preparation service to all Division employees. Slides can be created from most of the software packages used on the WRD minicomputers. Many employees have taken advantage of this service; more than one thousand 35 millimeter slides were generated in the DIS office during Federal fiscal year 1989. Slides can be created from most of the software packages used on WRD minicomputers. The DIS service is less expensive than commercial slide services. The only charges to the requester are for overnight delivery and slide developing, both of which are optional services.

The DIS Program office suggests basic guidelines for the design of computer files to be generated as effective 35 millimeter slides. These guidelines include editing techniques and style and color consistency.

The request is documented on a Slide Request form that records information such as name, phone number, shipping address, the type (Tel-A-Graf, Arc, Disspla ) and number of slides, the date the slides or film are needed, and whether overnight mail service is required. Once the request is initiated, instructions are given for transferring the required files into a designated computer directory on the Reston minicomputer. After the graphics files are received, a turnaround time of one week for undeveloped film, and two weeks for finished slides is required. Finally, electronic mail is sent to the author informing him/her know that the slides have been completed and shipped.

**CONFIGURATION AND CONTRACT MANAGEMENT FOR THE  
DISTRIBUTED INFORMATION SYSTEM-II OF THE U.S. GEOLOGICAL  
SURVEY**

**STILTNER, Gloria J., USGS, WRD, 12201 Sunrise Valley Drive,  
Reston, VA 22092**

The Distributed Information System-II (DIS-II) of the U.S. Geological Survey, Water Resources Division will eventually replace current DIS minicomputer systems. This process of transition from DIS to DIS-II is in its early stages of implementation. On the basis of scientific workstation technology and local area communications networks, DIS-II will provide a new generation of computer hardware and software. Distributed workstation processing will help to meet rapidly increasing demand for computing resources. Each site will have its own configuration of DIS-II workstations and supporting devices, which will be powerful enough to allow that office to do most of its work on site, and which will be known collectively as a DIS-II system.

The Distributed Information System Program Office at U.S. Geological Survey Headquarters in Reston, Virginia will have responsibility for the implementation of DIS-II. This office will provide technical expertise and support in the design and configuration of new systems and will assist each site in the analysis and selection of new computer technology to meet the site's current and future computer processing requirements.

The DIS Program Office will be responsible for all DIS-II contract administration, including advising, ordering, tracking, and managing the procurement, delivery, and acceptance of all DIS-II systems.

IMPLEMENTATION OF A LOCAL AREA NETWORK OF MICROCOMPUTERS TO  
COMPLEMENT MINICOMPUTER APPLICATIONS - A STATE OFFICE EXPERIENCE  
STRAUSE, Jeffrey L., USGS, WRD, 28 Lord Rd., Suite 280,  
Marlborough, MA 01752

The Marlborough, Massachusetts Office of the U.S. Geological Survey, Water Resources Division, operates a Local Area Network (LAN) of 17 IBM-compatible and 3 MAC-II microcomputers to complement software applications used on a remotely located (in Boston) Prime 6350 minicomputer. Ethernet cabling and Novell Netware software enable these microcomputers to share costly peripherals, such as laser printers and high-capacity mass-storage devices (fixed disk; compact disk-read only (CD-ROM); and write-once, read-many-times (WORM) drives). Used with the Prime LAN-to-host controller, this remote site can connect microcomputers directly to the minicomputer by the Ethernet-based network, eliminating the need for serial-port connection and asynchronous file transfer between microcomputer and minicomputer. Microcomputer applications include word processing, data assimilation and manipulation, statistical analysis, graphics display and output, and modeling. The primary benefits of this approach are faster operation for input/output-dependant software, such as word processing, reduced storage demands on the minicomputer, and greater accessibility to a wide variety of high-quality, relatively low-cost microcomputer software and peripherals. Implementation of an Ethernet-based LAN has the secondary benefit of developing skills with Ethernet cabling and administration of LANs that will be an integral part of the Survey's Distributed Information System-II at the State-office level.

#### MULTIPLE DATA BASE COMPATIBILITY ANALYSIS

TERRY, J.E., USGS, WRD, 2301 Federal Office Bldg., Little Rock  
AR 72201; MOORE, Lisa A., USGS, WRD, 2301 Federal Office Bldg.,  
Little Rock, AR 72201

In 1989 a committee was established to review the U.S. Geological Survey's (USGS) Ground Water Site Inventory (GWSI) data base. Part of this review involved a determination of the uniqueness of sites identified in GWSI and an evaluation of the compatibility of ground-water data stored in GWSI with ground-water data stored in the Survey's New Site-Specific Water-Use Data System (NEWSWUDS).

Methodology and supporting software were developed to compare GWSI data to data contained in NEWSWUDS in order to estimate the number of sites common to both data bases and the number of sites identified in one data base but missing from the other. Also, sites identified in GWSI were compared to each other to estimate the number of duplicate entries.

Sites were compared on the basis of "like" data elements--site identifier, local well number, latitude/longitude, state code, county code, hydrologic-unit code, water-use code (primary and secondary), and permit number. Preprocessing of data was necessary to determine the proximity of one site to another on the basis of latitude/longitude (proximity analysis). On the basis of only geographic location, the proximity analysis provides an initial estimate of which sites are "duplicates" in the GWSI data base, and which sites are "common" in the GWSI and NEWSWUDS data bases. A direct comparison of latitude/longitude for two sites requires an exact numerical equality to indicate a match. Therefore, in the final evaluation, proximity analysis estimates of like sites were used instead of numerical comparisons of latitude/longitude. Prototype applications of these procedures have been made for GWSI and NEWSWUDS data bases in five USGS Water Resources Division Districts.

This presentation describes the final data element comparison process, the scoring algorithm for estimating the likelihood of a match between two sites, the types of tabular output and summaries provided by the software, and preliminary results of the prototype applications. In the prototype applications these procedures seem to be reasonably accurate in identifying duplicate entries in GWSI and common sites in GWSI and NEWSWUDS.

COMPARISON OF FOUR PROCEDURES FOR ESTIMATING BASIN AND SUB-BASIN SLOPES BASED ON A GEOGRAPHIC INFORMATION SYSTEM

THOMAS, Richard P., USGS, WRD, 5821-D Midway Park Blvd. NE, Albuquerque, NM, 87109-5823; BLEAKLY, Denise R., Roy F. Weston, Inc., 5301 Central Avenue NE, Albuquerque, NM, 87108.

Four methods of calculating mean basin slope and sub-basin slopes from data in geographic information system coverages were compared: traditional contour length, modified contour length, triangulated irregular network, and mean slope curve. The basin data are contained in four coverages: topography, basin boundary, sub-basin boundaries, and stream-channel segments. Data from three small urban basins in Albuquerque, New Mexico were used in the analyses.

Statistically, there were no significant differences in results between the methods used to calculate mean basin slope, but there were significant differences in results between the methods used to compute mean sub-basin slopes. The traditional contour-length method and the modified contour-length method were the easiest to apply to geographic information system analyses. The traditional contour-length method consistently overestimated slopes, whereas the modified contour-length method produced satisfactory results for most slopes. The triangulated irregular network method produced consistently accurate slopes for all surfaces, but the procedures were more complicated and used a large amount of computer processing time and online disk storage. The mean-slope method was the least applicable to geographic information system analyses, and the results were similar to the contour-length method.

Procedures for slope calculations that are based on a geographic information system are less tedious and more accurate than conventional procedures. Computational procedures that previously have been considered too complex can be used rapidly and efficiently as an analytical procedure based on a geographic information system.

**NATIONAL WATER INFORMATION SYSTEM II SOFTWARE  
CONFIGURATION MANAGEMENT**

**THORNBERG**, Ruth E., USGS, WRD, 12201 Sunrise Valley Drive,  
437 National Center, Reston, VA 22092; **MERK**, Charles F., USGS, WRD,  
12201 Sunrise Valley Drive, 437 National Center, Reston, VA 22092

The U.S. Geological Survey is in the process of developing the National Water Information System II (NWIS-II) to integrate and replace the existing hydrologic-data and information systems. The new system is scheduled to be placed into operation by 1992 on a national and local network workstation environment.

Software development phases within the projected life cycle will generate many different system products including source and run code, test procedures, test data, and documentation required to define, develop, and maintain the system. A major challenge facing the development and maintenance of the NWIS-II will be to manage and control system products.

Software configuration management is a method for structuring a life-cycle management product whose primary goal is to maintain control through all of the life-cycle phases. The functions of configuration management are to identify, report, and document problems; establish a working version of the NWIS-II application as a starting point for further development; establish procedures for controlling changes; maintain libraries of all software and documentation developed; monitor problems and enhancements; manage system releases of approved software and documentation; and generate management reports. The objective of software configuration management is to establish formal automated procedures to support and control the NWIS-II life-cycle products.

This paper presents a management overview of instituting software configuration management for the National Water Information Systems Program Offices of the U.S. Geological Survey.

USE OF COMPUTER PROGRAMS TO ENHANCE WATER-QUALITY DATA PROCESSING  
TIHANSKY, Ann B., USGS, WRD, 4710 Eisenhower Blvd., B-5, Tampa, FL  
33634; KIESLER, Jay L., USGS, WRD, 4710 Eisenhower Blvd., B-5,  
Tampa, FL 33634

Computer programs to aid in the processing and quality assurance aspects of water-quality data are being used with increasing frequency within the U.S. Geological Survey. The Tampa office of the U.S. Geological Survey processes approximately 2,000 water-quality analyses each year. Three computer programs--QWRIP.SEG, REVIEW.CPL, and QWSORT.CPL--were developed to reduce the manual processing and review of water-quality data. These programs improve quality control by providing a tracking system for each analysis from initial storage to final approval and by performing logic tests among selected chemical constituents. These programs are compatible with the National Water Information System (NWIS) that operates on the Geological Survey's network of computers. Each program is a combination of the computer network's Command Programming Language (CPL) and Fortran.

The first program, QWRIP.SEG, sorts output generated by the water-quality data entry program (QWSYSTEM) and creates both GOODLIST and BADLIST files. The GOODLIST file contains analytical results that were successfully stored in the water-quality data base. The BADLIST file contains analytical results that were rejected by QWSYSTEM and were not stored in the water-quality data base. The BADLIST file also contains data that correspond to the BADQW file generated during data entry using QWSYSTEM of the NWIS software.

The second program, REVIEW.CPL, performs chemical logic tests and prints selected historical data from the data base. The chemical logic tests calculate the percent difference between field and laboratory values, predict the concentrations of selected ions based on specific conductance and compares these concentrations with laboratory results, and list historical data for comparison with new data. The historical data that can be reviewed using this program includes field-determined physical and chemical characteristics, chloride and specific conductance, major ion, and nutrient data. REVIEW.CPL produces a one-page table for each review category, depending on which characteristics or constituents are contained in each analysis. The third program, QWSORT.CPL, combines the output generated by the laboratory, the GOODLIST file produced by QWRIP.SEG, and the tables produced by REVIEW.CPL and arranges the output by site identification.

## DEFINING THE FUNCTIONAL REQUIREMENTS OF AN INTEGRATED NATIONAL WATER INFORMATION SYSTEM

TRAPANESE, Susan M., USGS, WRD, MS 437 National Center, Reston, VA 22092; CHRISTMAN, Jeffrey D., USGS, WRD, MS 437 National Center, Reston, VA 22092; BRIGGS, John C., USGS, WRD, MS 437 National Center, Reston, VA 22092

The U.S. Geological Survey is designing a second-generation integrated national water information system, NWIS-II. A centralized team, the Integration Team, was formed to analyze and integrate the data and functional requirements defined by eight user groups representing the major scientific disciplines and interests within the Survey's Water Resources Division. This paper will concentrate on the effort to define the functional requirements for the NWIS-II. The Integration Team categorized all the needs specified by the user groups into nine major functional areas: input and edit, data verification, computations, selection criteria for data retrieval, output, system security, data base and software maintenance, project or data section management, and software user interface. Definition of the the major functions involves formal reviews, communications between the Integration Team and the user groups, and the exchange of technical documents that further define and detail users' needs. Refining the functional needs of the NWIS-II is a continuing process.

The NWIS-II, as specified by the user groups, will be in sharp contrast to the first-generation National Water Information System (NWIS). Separate data bases and data management systems for the various scientific disciplines will be replaced by a single integrated system. The users will access the NWIS-II through multiwindowed, multitasking UNIX workstations. The eventual inclusion of a geographic information system capability to the NWIS-II will allow users to retrieve, input, and verify data by spatial-relation characteristics. The use of simple English terminology to query the NWIS-II for data retrievals will be possible. The user groups have specified a system having word-processing capability, including page layout, graphics, statistics, and spreadsheet programs. The user groups also specified a system having the flexibility of defining data input and output formats, computations, and statistical analyses, in addition to the various computational processes for hydrologic data already incorporated into the first NWIS.

Implementation of NWIS-II by 1992 is a realistic goal. Parts of the NWIS-II software will be written by Survey personnel; available commercial software will be used to meet most of the functional requirements specified by the user groups.

**A PROGRAM TO DIGITIZE CHARTS HAVING NON-STANDARD  
COORDINATE SYSTEMS**

WERLEY, Mark R., USGS, WRD, 300 W. Congress St., FB-44, Tucson, AZ  
85701

DIGIBRIS (DIGItize BRIStol) is a Fortran program developed for digitizing Bristol series 500 and 530 charts. Bristol charts are circular and have a non-standard coordinate system that resembles a polar coordinate system except that the radial lines are arcs of circles, not straight lines. Thus, digitizing a Bristol chart is not a simple polar to rectangular conversion and presents a challenging programming and trigonometric exercise.

In Arizona, Bristol charts are used to record water levels at sites where sediment compaction is being monitored. Reading these charts and manually entering the data into the U. S. Geological Survey surface-water data base is a laborious, repetitive, and error-prone task. The program creates an output file in a standard format suitable for uploading directly into the data base. Using the program to digitize Bristol charts, as opposed to reading and manually entering them, vastly reduces the effort required to enter data into the surface-water data base and also provides improved accuracy.

DEVELOPMENT OF THE NEW NATIONAL WATER INFORMATION SYSTEM OF THE  
U.S. GEOLOGICAL SURVEY

WILLIAMS, Owen O., USGS, WRD, MS 437 National Center, Reston, VA  
22092; YORKE, Thomas H., USGS, WRD, MS 437 National Center, Reston,  
VA 22092

The U.S. Geological Survey, Water Resources Division, is currently (1990) designing and developing a new version of the National Water Information System (NWIS-II), which will be distributed across the Nation on 32-bit microprocessors using dedicated data-line and local-area-network technology for telecommunications. The NWIS-II will replace existing systems for the storage, retrieval, and management of water data--the National Water Data Storage and Retrieval System (WATSTORE), the National Water Data Exchange System (NAWDEX), the PRIME-based National Water Information System (NWIS), and the Water-Use Data System.

Four working groups that were established to address various aspects of the development of the NWIS-II are as follows: (1) Strategic Planning, (2) Integration, (3) Users, and (4) Software Quality Assurance and Configuration Management.

The Strategic Planning Group provides the overall policy and guidance for development of NWIS-II. The Integration Group develops the plan for the data-base structures and processing functions necessary to implement NWIS-II. The Users Group consists of eight disciplinary subgroups (Surface Water, Sedimentation, Quality of Water, Biological Systems, Ground Water, Water Use, NAWDEX, and Spatial Data) that describe the users' needs and expectations, especially those unique to the discipline, as well as the processes and constraints for the NWIS-II software system. The Software Quality Assurance and Configuration Management Group establishes software standards and guidelines, and coordinates formal reviews for the continuing development and maintenance of NWIS-II throughout its life cycle.

## DEMONSTRATION OF AN EARTH SCIENCE HYPERMEDIA SYSTEM

WILTSHIRE, Denise A., USGS, 801 National Center, Reston, VA 22092

In May 1988, the U.S. Geological Survey established a cooperative program with representatives from the Arctic research community to facilitate data management. One of the key activities that the U.S. Geological Survey has undertaken is membership in the Arctic Environmental Data Directory Working Group, which is sponsored by the Interagency Arctic Research Policy Committee. The working group is composed of representatives from other government agencies and academia. One of the goals of the working group is to facilitate access to earth science data and information for the Arctic and hence improve dissemination. As a first step the working group developed the Arctic Environmental Data Directory, which contains more than 250 references to Arctic data sets maintained by United States Government agencies and other institutions. To meet the data management goals of the Interagency Arctic Research Policy Committee, the working group has undertaken a pilot study, known as the Arctic Data Interactive (ADI), to design an integrated information product that will be published using compact disk read-only-memory (CD ROM) technology. The ADI prototype will include the following multimedia elements:

- Arctic Environmental Data Directory
- Bibliographic information
- Full text of research reports and/or short papers (including illustrations)
- Arctic data sets

The project entails developing a prototype of an electronic journal that includes a mix of textual, numeric, and spatial data and possibly related software for data analysis. The data will be in standard formats to facilitate use with other applications software such as spreadsheets, graphics, and image processing.

The design of the ADI prototype is based on the concept of hypermedia technology. Hypermedia is defined in the computer and information science literature as a software environment for developing non-sequential data-base-management systems. Hypermedia techniques provide the capability to create associative links between structured and unstructured information that may include data, text, graphics, imagery, and sound. Hypermedia systems are also characterized by a user interface that incorporates icons (graphic representations) and multiple windows on a computer monitor. Experimentation with hypermedia technology in this study is an attempt to integrate a broad range of multimedia formats into one product that will facilitate access to Arctic digital data and information.

A TERMINAL-EMULATION PROGRAM (SMTERM) FOR RETRIEVING  
ELECTRONICALLY COLLECTED DATA ON MINICOMPUTERS

YANCEY, David K., USGS, WRD, Room W-2519, 2800 Cottage Way,  
Sacramento, CA 95825; MCFARLANE, Scott I., USGS, WRD, Room W-2518,  
2800 Cottage Way, Sacramento, CA 95825

Use of electronic data storage modules in conjunction with dataloggers provides a reliable and efficient means for on-site, battery-backed data storage and easy transportation of field data back to the office. SM192/721 storage modules, from Campbell Scientific, Inc., use interactive telecommunication commands for data retrieval and, therefore, need to be connected to a telecommunication terminal or a computer that has appropriate telecommunication software.

For use with a U.S. Geological Survey Prime minicomputer, the only suitable telecommunication software available was the Survey's terminal-emulator program called Termem; however, the program did not successfully retrieve all data when using a communication rate of 9,600 baud. Depending on system load, a 1,200 baud rate is usually slow enough so that there is no loss of data; however, a retrieval may take more than an hour. An alternative, which can also be a lengthy operation, is to use proprietary hardware and software that allows data to be unloaded to a microcomputer; the data would then have to be transferred to the minicomputer.

To provide an efficient means for unloading storage-module data directly to the Survey's minicomputer, a storage-module terminal-emulator software utility was developed called Smterm. It is an extensive modification of the Termem program, which uses reverse flow control (reverse XOFF protocol) to prevent overruns of the minicomputer's input queue at any baud rate. Processing time for data retrieval can be shortened by the program's option to disable terminal output during data transfer. It also incorporates special features for automatically (1) establishing the communication link; (2) issuing appropriate commands to retrieve data; and (3) creating an archive copy of the data.

## GLOSSARY

- 2- and 3-card format – An acceptable format for the entry of daily-values data to the Daily Values File that is a part of the USGS Water Data Storage and Retrieval System (WATSTORE) that is located on the AMDAHL main-frame computer in Reston, Virginia. This is also a supported output format in the Automatic Data Processing System (ADAPS), which is a part of the distributed National Water Information System (NWIS) that is installed on PRIME minicomputers nationwide. Daily-values data are uploaded from the local ADAPS daily-values data files to the WATSTORE daily-values file on the AMDAHL in this format.
- 32-bit microprocessor – A microprocessor that uses a word size of 32 bits.
- aeromagnetic field – A representation of the earth's magnetic field as determined from measurements made from the air at some known distance from the earth's surface.
- asynchronous – Data transmission in which each information character is individually synchronized, usually by the use of start and stop elements or bits.
- band ratios – In remote sensing, the process of enhancing the spectral response of vegetation in an image. The process is as follows in terms of radiation: (infrared / red)
- batch job – A program or a set of programs that is part of a sequential group or queue. Each member of the group is executed in turn as a job on the computer according to its position in the queue.
- bathymetric data – Data describing the topology of a lake bottom with respect to the lake's water surface.
- baud – A unit of signaling speed. The reciprocal of the duration, in seconds, of the shortest signaling element that a channel can accommodate. Commonly used units are bits per second.
- bit – A unit of data that is indivisible. It is the choice between two possible states, usually designated one and zero.
- byte – A sequence of adjacent bits operated on as a unit and usually shorter than a word.
- central processing unit (CPU) – A CPU is made up of a processor unit that implements the operations in a computer and a control unit that supervises the sequence of micro-operations.
- compiler – A program that translates high-level computer programming language (such as Fortran) into machine language.
- coverage (GIS) – A GIS coverage is a set of information that digitally describes a geographic area using appropriate types of feature-class data.

digitizing – The process of converting data that is expressed visually in the form of maps, line charts, and so forth, into numeric form. The process can be manual or can be greatly automated by using an electronic digitizer.

disk storage – A storage medium available on most computers. The disks are magnetic and come with various storage capacities. Disks may be repositories for both data and computer programs.

double precision – A numeric representation may occupy twice the amount of space it normally would. For example, double precision might be specified for a numeric variable to adequately represent the precision required by a particular type of calculation.

ethernet – Facilitates communications between mini and mainframe computers, workstations, personal computers, and peripheral devices: Currently limited to 10 megabytes.

geographic information system (GIS) – Computer hardware and software system designed to collect, manage, analyze, and display spatially referenced data.

gravity field – A representation of the earth's magnetic field as determined from specific measurements made on the earth's surface.

hardware – Any physical equipment related to a computer including the computer itself.

image-processing – The process of interpreting, refining, and manipulating data collected by remote sensing or satellite imagery.

interactive – A mode of operation on computers in which the user is communicating directly with the computer through the operating system software or user software that has been invoked.

interface – A common boundary where independent systems meet and act on or communicate with each other.

limnology – The study of lakes.

local area network – A network of computer equipment that shares resources and is physically located at the same site.

mean slope curve – Method of determining slope of a surface on the basis of the relation between the width of the elevation contour interval and the corresponding changes in elevation.

megabyte – One million bytes (see byte).

menus – In computer terms, a menu is a list of available options that is displayed on the monitor screen. The user may select from the list and that selection determines the next course of action taken by the software that is currently invoked.

microcomputer – The term is general and refers to a small-size computer system with three basic units: central processing unit, memory, and an input-output interface.

modified contour length – A method of determining slope of a surface plane modified from traditional contour length method by subtracting a mean contour from the sum of contour lengths.

multitasking – Refers to a computer that can do multiple tasks concurrently.

multiwindowed – Refers to a computer that can display more than one interface on the monitor screen at the same time.

normalized difference – In remote sensing, the process of enhancing the spectral response of vegetation in an image. The process is as follows in terms of radiation:  
$$\frac{(\text{infrared} - \text{red})}{(\text{infrared} + \text{red})}$$

point-coverage file – A GIS coverage that has points defined by geographic location and associated attributes.

postscript – A page-description language used primarily for printing illustrations and including them in other documents.

random-access memory (RAM) – RAM is volatile, dynamic computer memory, sometimes referred to as 'main memory'.

raster data – Data representation using grid cells.

real variables – In computer programming, these are variables that are designated to represent real numbers.

relational data base – A data base that is made up of elements and files that are linked as a result of defined connections.

scanner – A device that can be used to interpret printed data and transpose that data into a digital form that can be used for further processing.

software – Software is computer programs.

termem program – A terminal emulation program currently in use on minicomputers in various Water Resources Division offices.

traditional contour length – The traditional method of determining slope of a surface plane based on summing lengths of contours, multiplying by contour interval, and dividing by area.

triangulated irregular network – A method of determining slope of a surface plane using a type of digital elevation model consisting of a network of irregular triangles created by interconnecting elevation points.

usage utility – A utility program provided with the PRIME minicomputers that allows the system administrator to evaluate system performance.

vector data – Data representation using line segments.

word – An ordered set of characters that is the normal unit in which information may be stored, transmitted, or operated on within a computer. Word sizes may vary from one type of computer to another.

workstation – A microcomputer that is connected through a local area network (LAN) to other, usually more powerful, microcomputers designated as servers and to other shared devices such as printers and plotters.

xoff/xon protocol – The means by which a computer or peripheral device is able to stop and start data transmissions in order to maintain the integrity of storage buffers.